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TRW DEFENSE AND SPACE SYSTEMS GROUP REDONDO BEACH CA
TEMPLATE-ASSISTED INTELLIGENCE FUSION PROGRAM (TEMPRO) (U)
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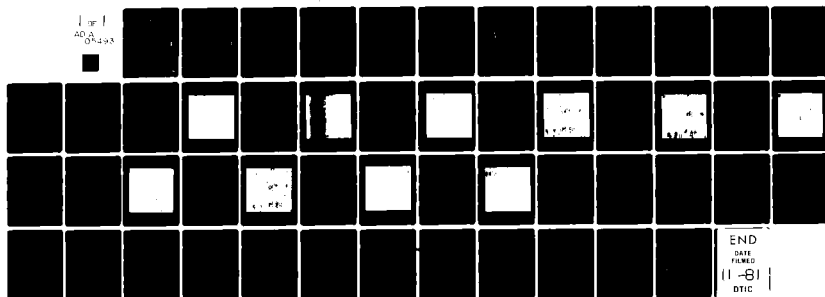
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FINAL REPORT FOR

LEVEL II

TEMPLATE-ASSISTED INTELLIGENCE FUSION PROGRAM (TEMPRO)

PREPARED BY
D.H. NEWELL

June 1979

CONTRACT NO. DAEA18-77-C-0180
CDRL ITEM A012

Prepared for

UNITED STATES ARMY INTELLIGENCE CENTER AND SCHOOL
FORT HUACHUCA, ARIZONA

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PREFACE

TEMPRO is a computer-based system built at a prototype level to evaluate battlefield command support decision processes. The system was designed and built by TRW under contract to the United States Army Intelligence Center and School (USAICS). Contract objectives were centered on the support of corps-level commands regarding the location and disposition of enemy forces. A European setting at the Fulda Gap was selected and modeled in depth to provide both input data to the program and an operating data base. SCORES IIA data were used and augmented with extensive data (particularly air defense communications, data, and radar transmissions) taken from classified sources. This summary report describes the information that TEMPRO produces for command support use. System details are contained within the Programming and User Manual, CDRL Item A0101.

The TEMPRO contract began with an analysis of enemy force descriptors that could be sensed from SIGINT and IMINT collectors. These descriptors were organized into identifying characteristics of different force units called unit templates. A computer data base of these templates was constructed and used against simulated intelligence input data for (a) data correlation, (b) enemy cover and deception detection, and (c) enemy unit identification (or partial identification).

TEMPRO was built to operate on the PDP-11/45 and 11/70 computers under RSX 11M and 11D. Results are displayed on a multi-color CRT. Operator interaction occurs through standard DEC terminal devices. Operation of the system has demonstrated that advanced algorithms and extensive data handling techniques can provide the processing timeliness and accuracy necessary in a tactical environment.

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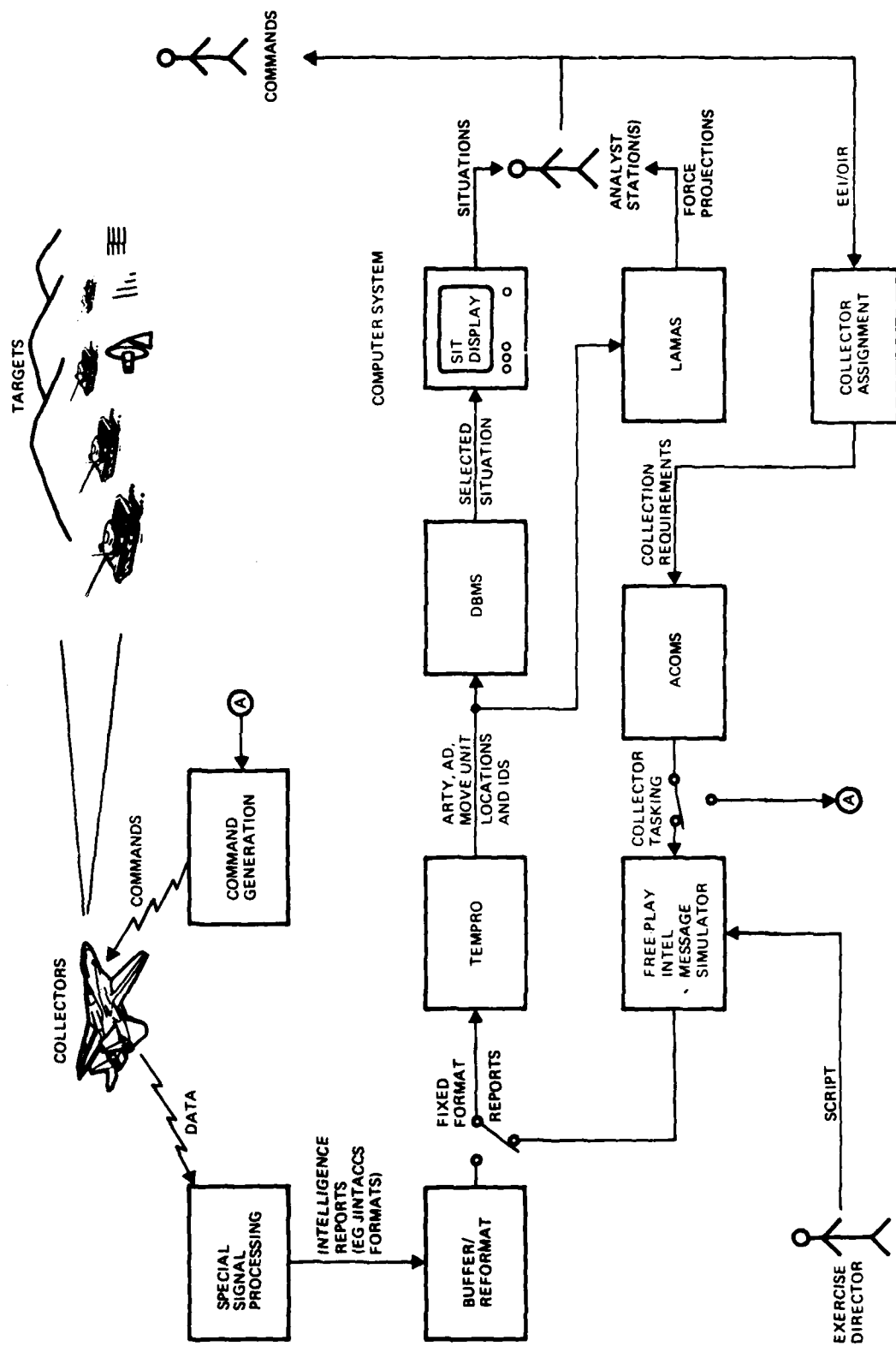
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1. COMMAND SUPPORT NEEDS

COMMAND SUPPORT NEEDS

TEMPRO is a command support applications tool. It represents one of several tools necessary to assess the enemy location and intent of forces. The facing diagram shows intelligence and contract information flowing from friendly collectors to computer-aided enemy situation analysis stations. The intelligence and combat information data are presented to TEMPRO to develop enemy unit locations and identifications. TEMPRO draws upon stored templates and operator/analyst knowledge to perform its functions.

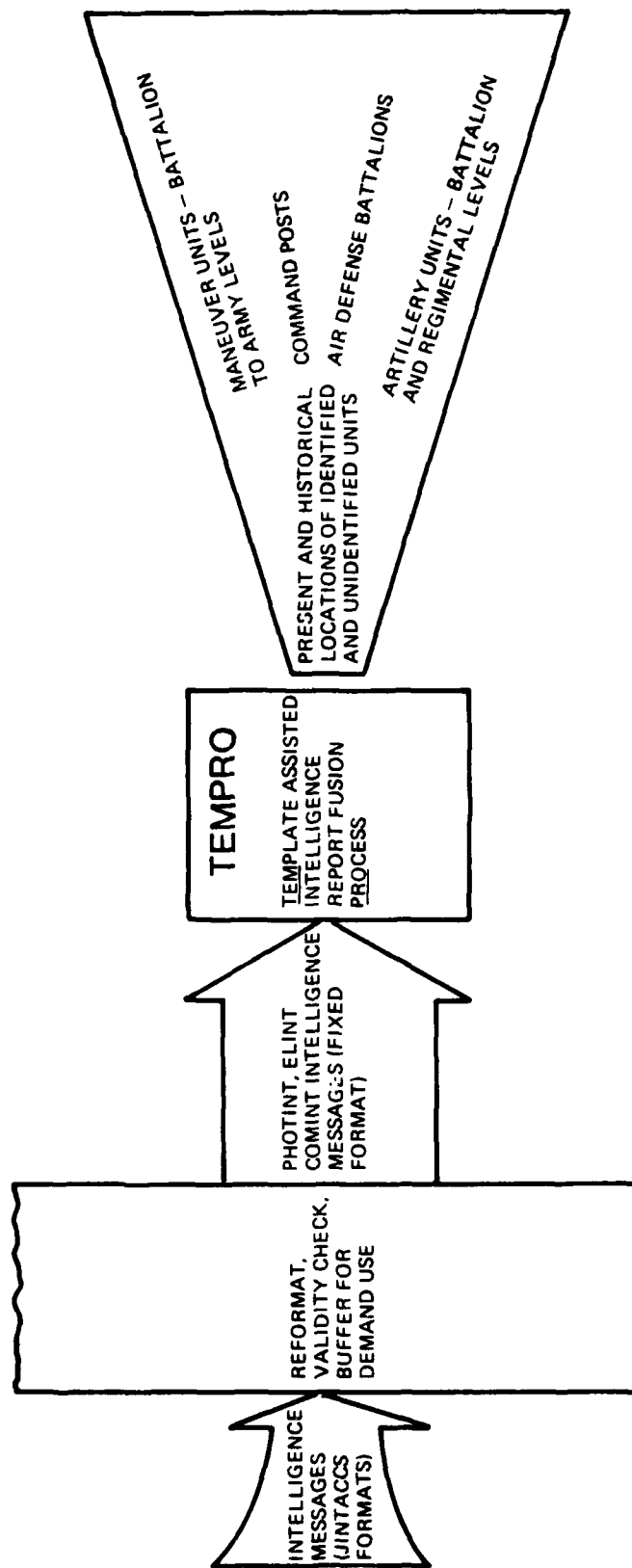
Other command support functions use TEMPRO results. LAMAS operates on TEMPRO-generated enemy unit locations and identifications to project the locations ahead in time according to enemy doctrine and the tactical situation. This projection enables the tasking of intelligence collection assets to acquire relevant future data. EEIs, OIRs, and specific intelligence requests flow to ACOMS, a function which sorts and optimally assigns the requests to collectors. LAMAS and ACOMS have also been developed by TRW and operate in concert on the same computing hardware as TEMPRO. LAMAS and ACOMS are described in separate reports.



TEMPRO CORRELATES ALL-SOURCE DATA

Intelligence and combat information in fixed-field format from all sources (SIGINT and IMINT) are input to TEMPRO in time-of-arrival order from collection platforms. The data input to TEMPRO are not in the time order of collection. Because certain collectors provide data quickly and others reflect a time lag due to special processing or handling, TEMPRO automatically orders the data and compares it with data existing in the data bases. Using templates and advanced algorithm techniques, data fusion is accomplished to compute and display the enemy unit locations, both identified and unidentified.

The software that performs these TEMPRO functions enables processing of large data volumes at high rates. In addition, numerous software functions can be activated by the operator to analyze the data in detail. For example, the operator can elect to zoom the screen into a small area and display push-to-talk radio intercepts only or SA-6 related radars.



BOLD EAGLE ADP LESSONS LEARNED FOR TEMPRO

In 1976, Special Project BOLD EAGLE was conducted to evaluate the utility of certain kinds of intelligence in a tactical environment. For automatic data processing (ADP) elements, tests were conducted to identify user needs for intelligence integration and analysis and to determine automated support and associated tactical data bases.

Along with numerous positive lessons, BOLD EAGLE illuminated several ADP shortfalls:

- System ability to input data was slow, limiting throughput
- Final utility of the intelligence was limited.

During BOLD EAGLE simulated intelligence data entered the system as hard copy, requiring operators at message input terminals to enter information manually. Additionally, much of the report data was textual (MISREP, INTSUM, and DISUM), requiring operators to interpret data and transcribe to fixed-field input formats. Both of these manual activities consumed much time and accounted for the throughput limit. After intelligence was entered into the system, access and analysis were slow because of the lack of interactive graphics; it was difficult for the analyst to know what to request of the data base. These shortfalls helped shape the emphasis of TEMPRO. Input message handling and color graphics are key elements of TEMPRO in aiding analyst interpretation.

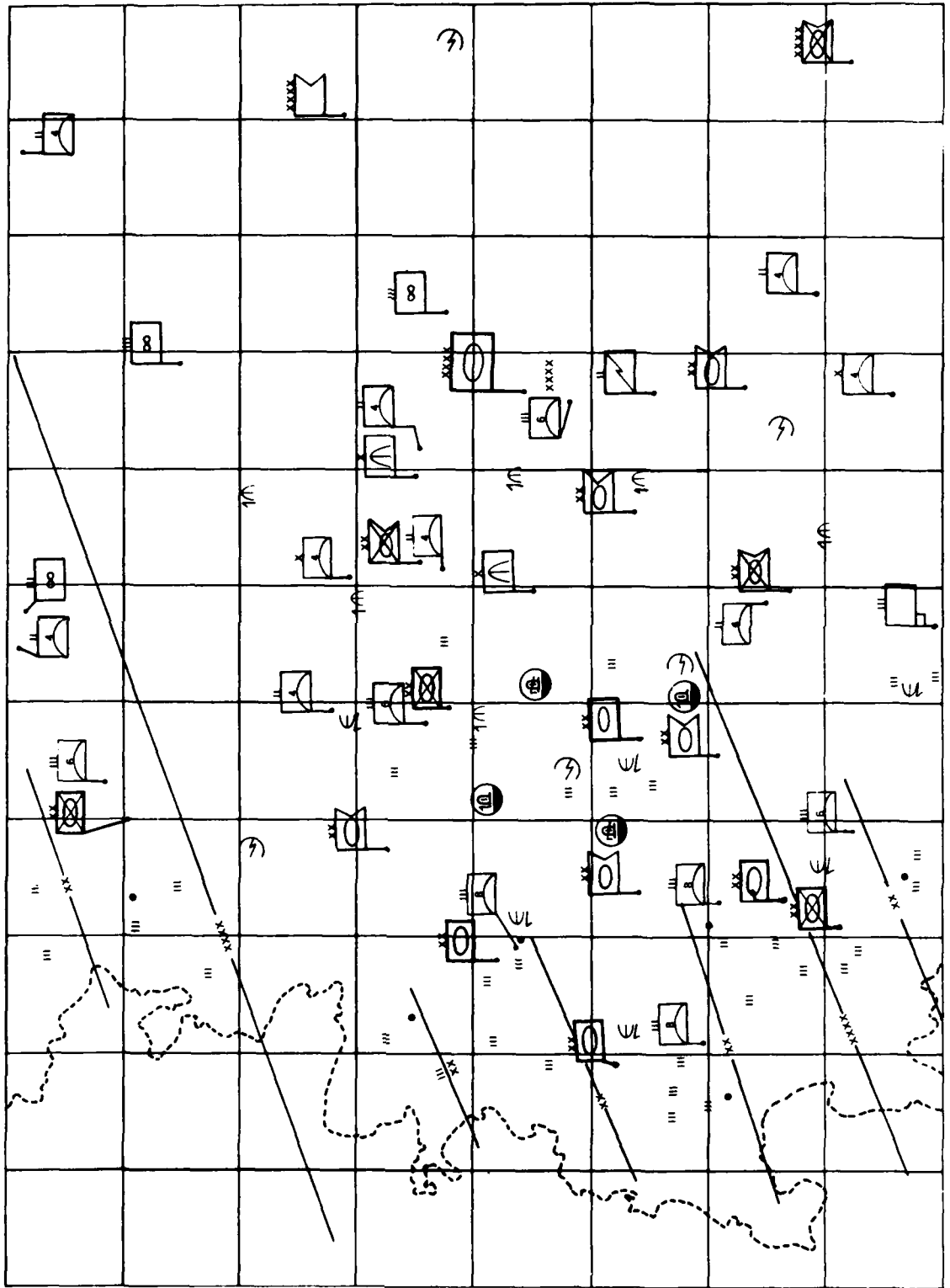
2. ENEMY GROUND FORCE SCENARIO

ENEMY GROUND FORCE SCENARIO

Enemy ground force descriptive data were extracted from SCORES, Sequence IIA, and augmented with data from classified sources to define an intelligence collection environment. The environment focused on second-echelon divisions of a first-echelon army. Enemy units were defined down to the battalion level; company-sized units were grouped together with the exception of those units that presented a unique profile or electronic emission; these units were treated separately. (*Template characteristics of units are defined later in this report.*) Data from the enemy ground force units are described in detail in the Programming and User Manual, CDRL Item A0101.

TEMPRO was operated against simulated data from this augmented SCORES IIA data base. In Section 3, the results of TEMPRO processing from the early part of the scenario—monitoring for indications and warning — are shown. In Section 4, the results of an active battle situation are shown — assessing the second-echelon force.

A detailed description of the scene is contained in the TRW/Advanced Studies Report, Reconnaissance Force Requirements for Critical Node Analysis (U), June 1979, Top Secret (SAO), Defense Nuclear Agency Report No. DNA-4912F.



3. MONITORING FOR INDICATIONS AND WARNING

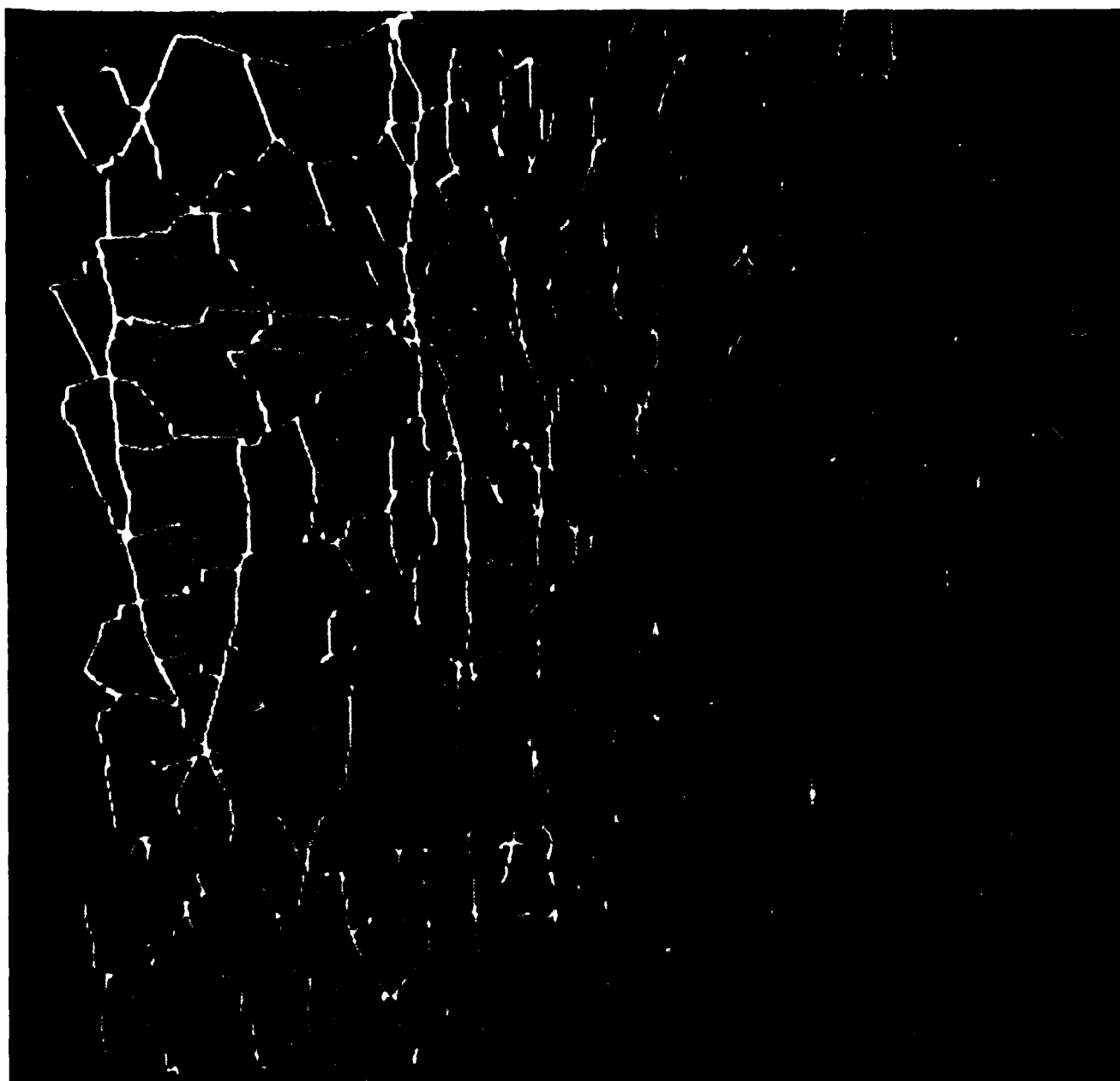
MONITORS FOR INDICATIONS AND WARNING

Three divisions of an enemy army are poised in the second echelon as possible exploitation forces behind breakthrough divisions. The identity and current location of the exploitation force are not known. Intelligence collection platforms have been deployed to monitor radar and radio emissions and to gather imagery. At this point, it is essential that friendly commands know the size, location, and identification of these second-echelon units.

As the intelligence reports are made available to TEMPRO, report correlation is performed to determine location and unit identifications to the extent possible.

When a report is first introduced to the program and TEMPRO infers that a new unit has been detected, a blue unit symbol is displayed on the TEMPRO CRT. Unit identification is often incomplete as shown in the figure below. One unit symbol is an empty box indicating that a valid report was collected, but no unit sizing or identification can be made.

When a report is received which matches an existing blue unit according to the TEMPRO fusion algorithms, the reports are correlated. To show this, the unit symbol turns to red and is assigned an arbitrary number (unless actual unit identification has been made). Once a unit is correlated, a tracing of its movements is also displayed in red. The figure on the facing page is a photographic reproduction of the TEMPRO COMTAL display with the LOC nets. The geographic area for this display is 79 by 77 km within the FRG.



REPORT SUMMARY

The operator has the option of monitoring intelligence reports as they enter TEMPRO. Shown below is an example of one of the reports in the report stream. It contains information including time of collection and reporting, location, collector source, collector sensor, collector uncertainty, and vehicle counts. Location is shown in modified UTM coordinates to directly register with standard 1:50,000 scale maps.

This simulated imagery report, which has been put in a standardized format, indicates that 52 vehicles have been detected (grouped at 5624,606) but no vehicle identifications are possible. The PI was able to determine that the unit is a division command post with support elements, but identification of the unit type was not possible. TEMPRO will operate on this report to create a templated report.

CORRELATION MONITORING

As TEMPRO correlates the reports, the operator can monitor the results as a system option. This example, Report No. 13, was explicit enough to completely determine the type of unit, a marching tank regiment. The report was correlated with another marching tank regiment, Report No. 5, to create a new Unit No. 13.

ID LIST FOR REPORT # 13

TWK FGMT MARCHING 100%

PROBABLE DEFECTIONS ARE WITH:

REPORT #

DEFECTION MEASURE =

974

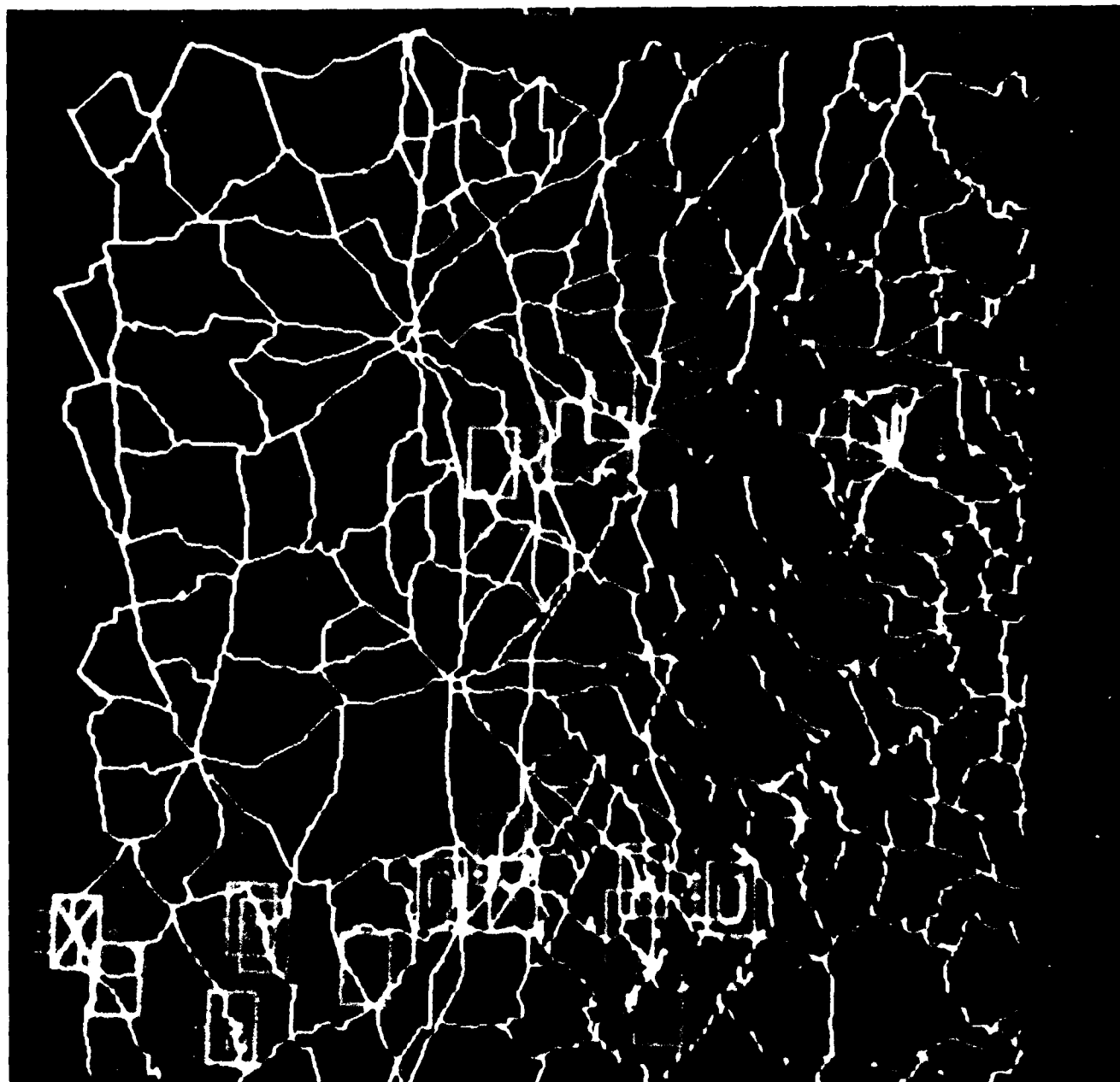
REPORT ON TWK FGMT MARCHING

REPORT #

5

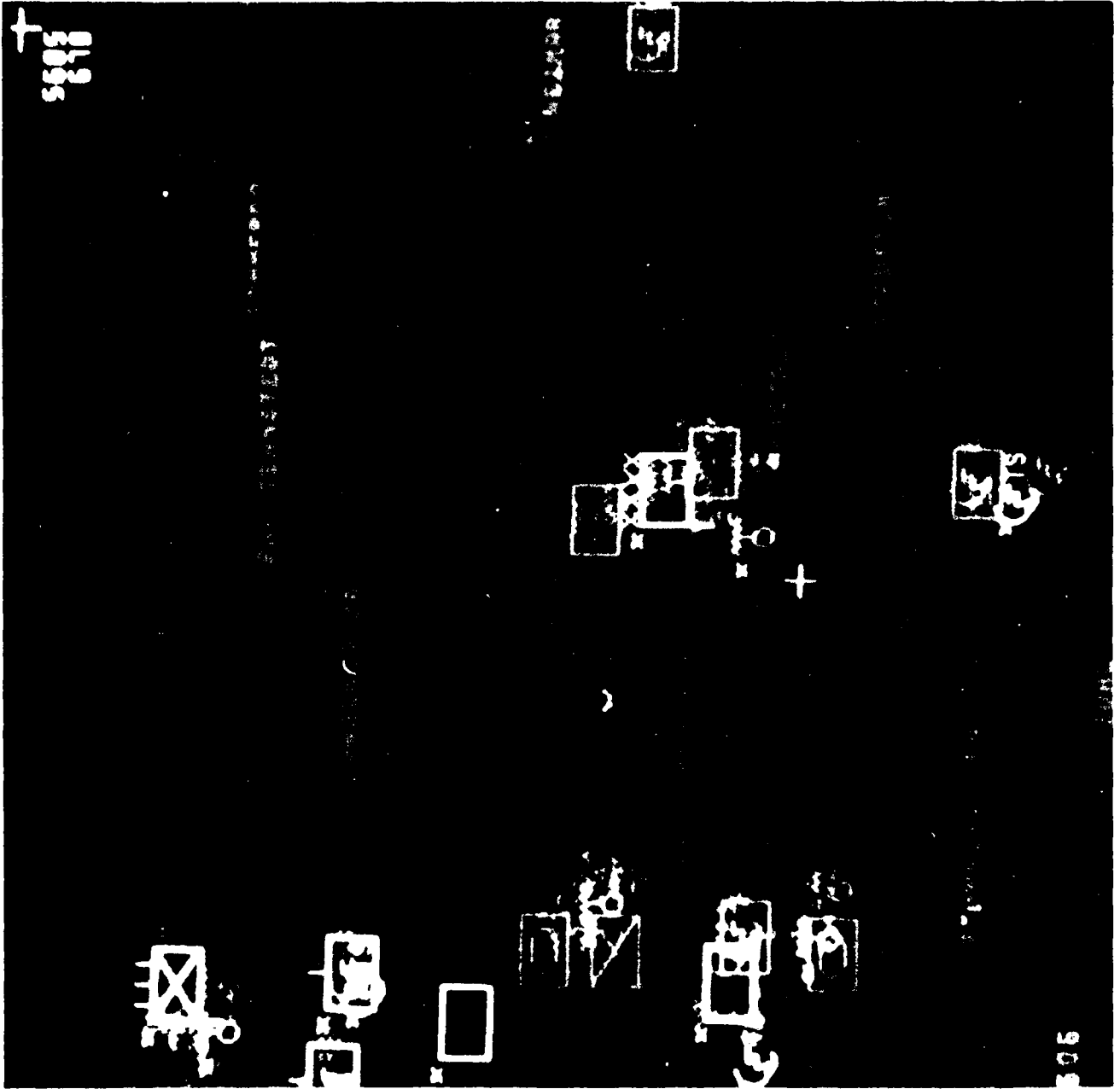
THE SITUATION AFTER 100 REPORTS ARE PROCESSED

Processing continues as intelligence reports flow into TEMPRO, and a more complete view of the force constitution is displayed. Enough information has been processed to start looking for enemy indications and warnings. A number of units are massed along the left border, including a second-echelon division plus early-warning companies. An army command post plus surrounding unidentified units are observed in the centers. It is now a good time for the analyst to look at certain areas more closely to gain a more complete appreciation of enemy activities.



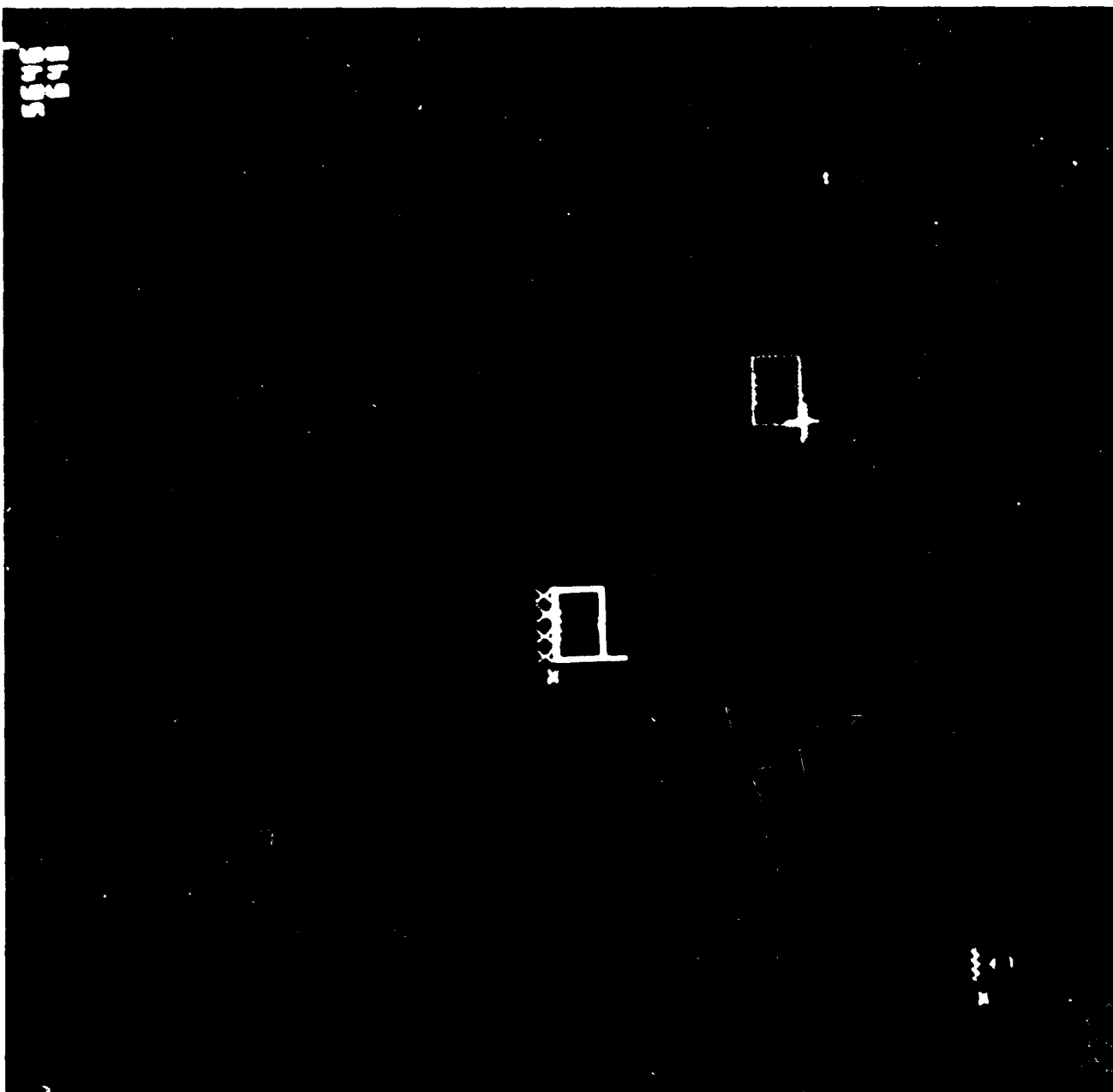
NO INDICATION OF ATTACK

After 100 reports have been processed, operator interaction is invoked. This enables the user to look more closely at the displayed situation. He may magnify a certain area, find the location of various elements, and review the reports processed. This figure shows the same scene as on the previous page, but now the roads have been erased, and all radio and radar reports have been displayed. The operator has elected to change the color scheme; uncorrelated reports are now yellow, and cities and geographical registration marks are displayed in blue. Much radio activity is taking place, indicating that the units are still assembled. Now is the time to task intelligence collection assets to verify this deduction and to immediately alert friendly commands of a change in emission patterns or a movement of the units.



COMMAND POST AREA MAGNIFIED

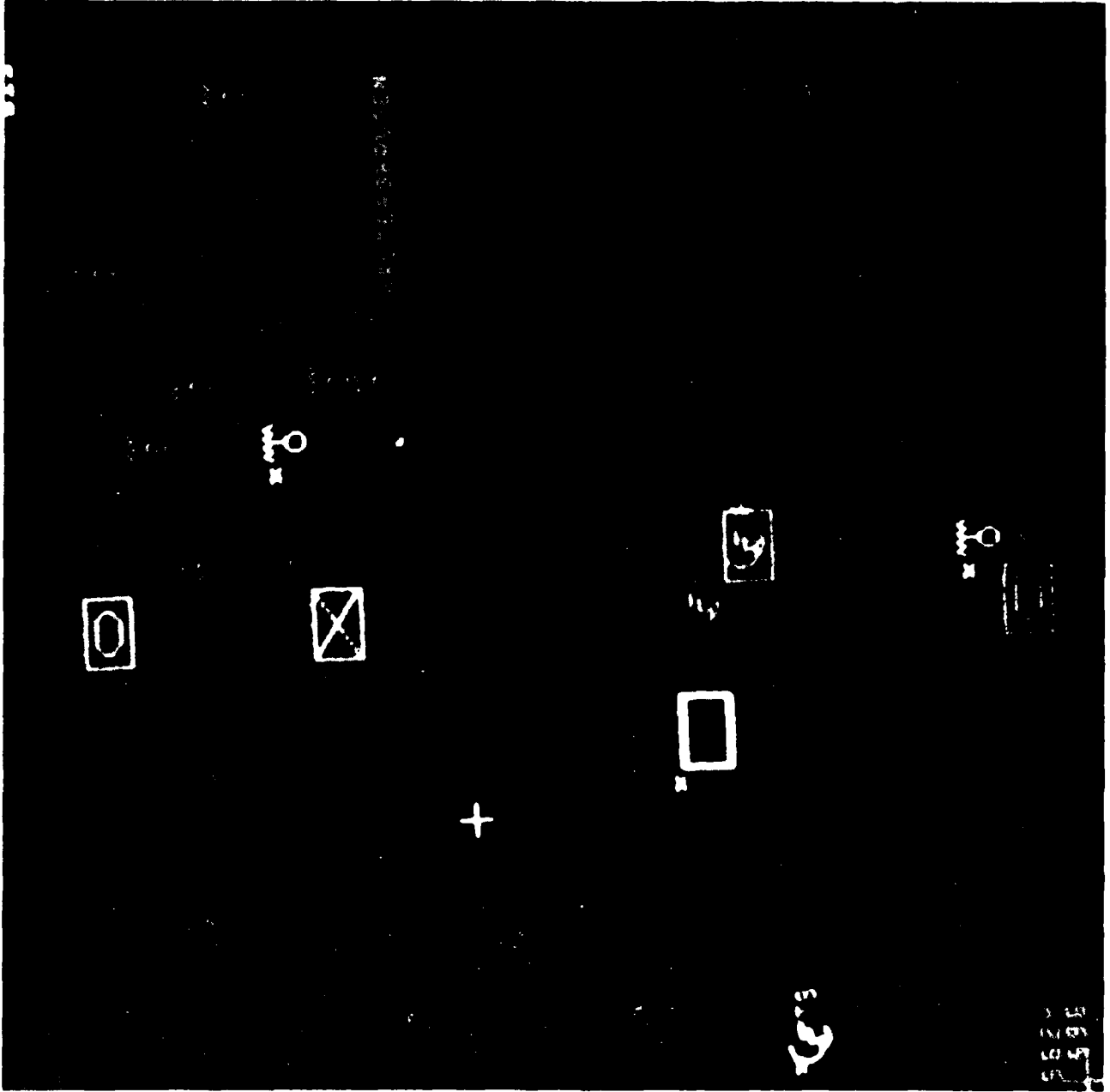
Zooming into selected geographical areas enables the analyst to investigate local situations more closely. Command posts are of particular interest, so the area around the army main command post is magnified. By placing the trackball cursor on Unit No. 5, the user causes TEMPPO to print the reports which led to the creation of this unit (not shown in the figure). Inspection of these reports shows that both Unit No. 5 and Unit No. 6 are command posts of either a division (most likely) or army level. Close monitoring of this area is crucial to timely indications and warning.



4. ASSESSING THE SECOND-ECHELON FORCES

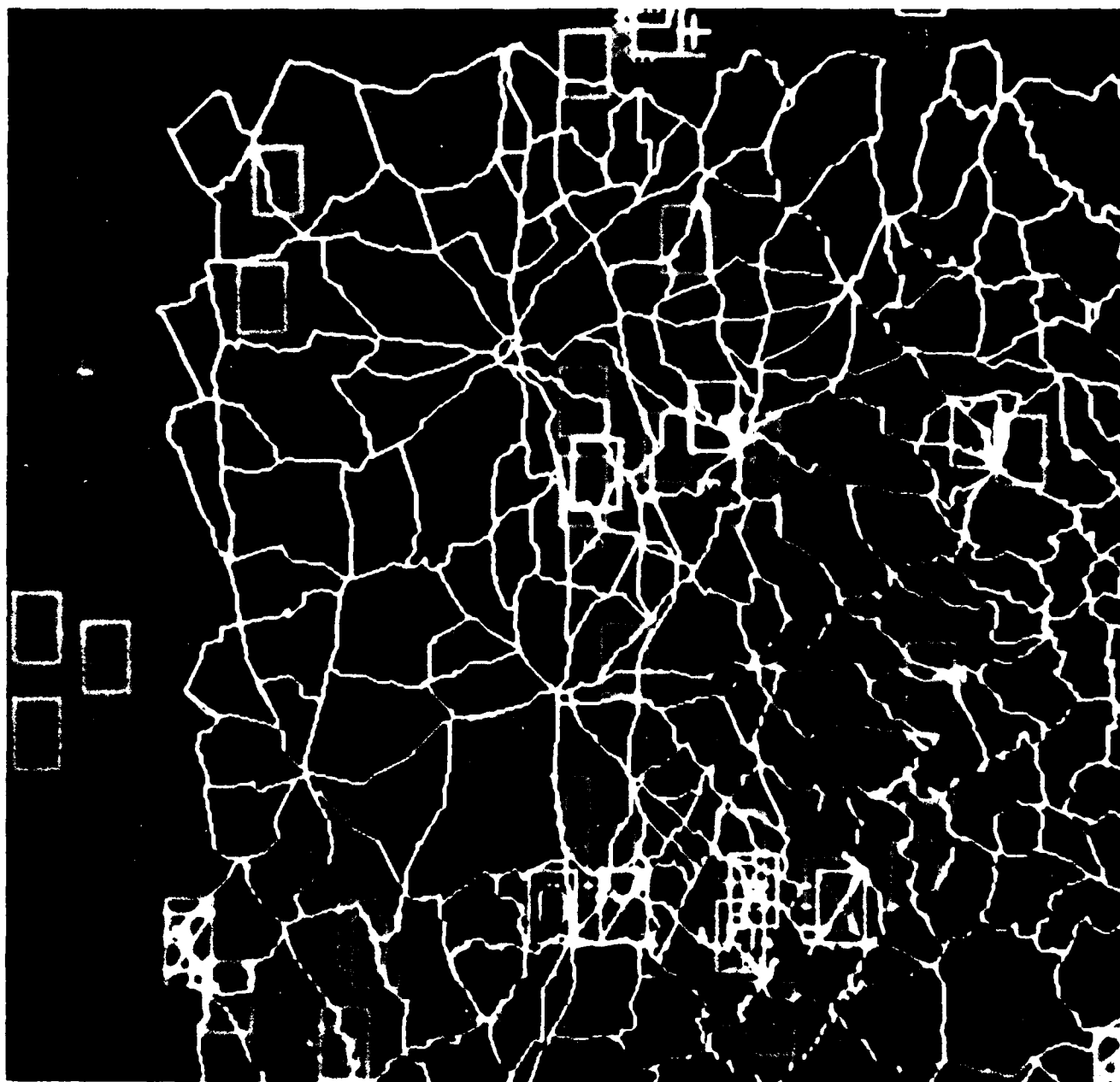
ASSESSING THE SECOND-ECHELON FORCES

Continuing with the previous scenario, the second-echelon forces will begin to change positions as a hypothetical attack begins. The opposite page shows one of the second-echelon divisions that TEMPRO has thus far located (Section 3). Friendly commands must know when these units start to move and the general direction of movement. The area coordinates provide geographical information for intelligence collection tasking.



THE SITUATION AFTER 200 REPORTS

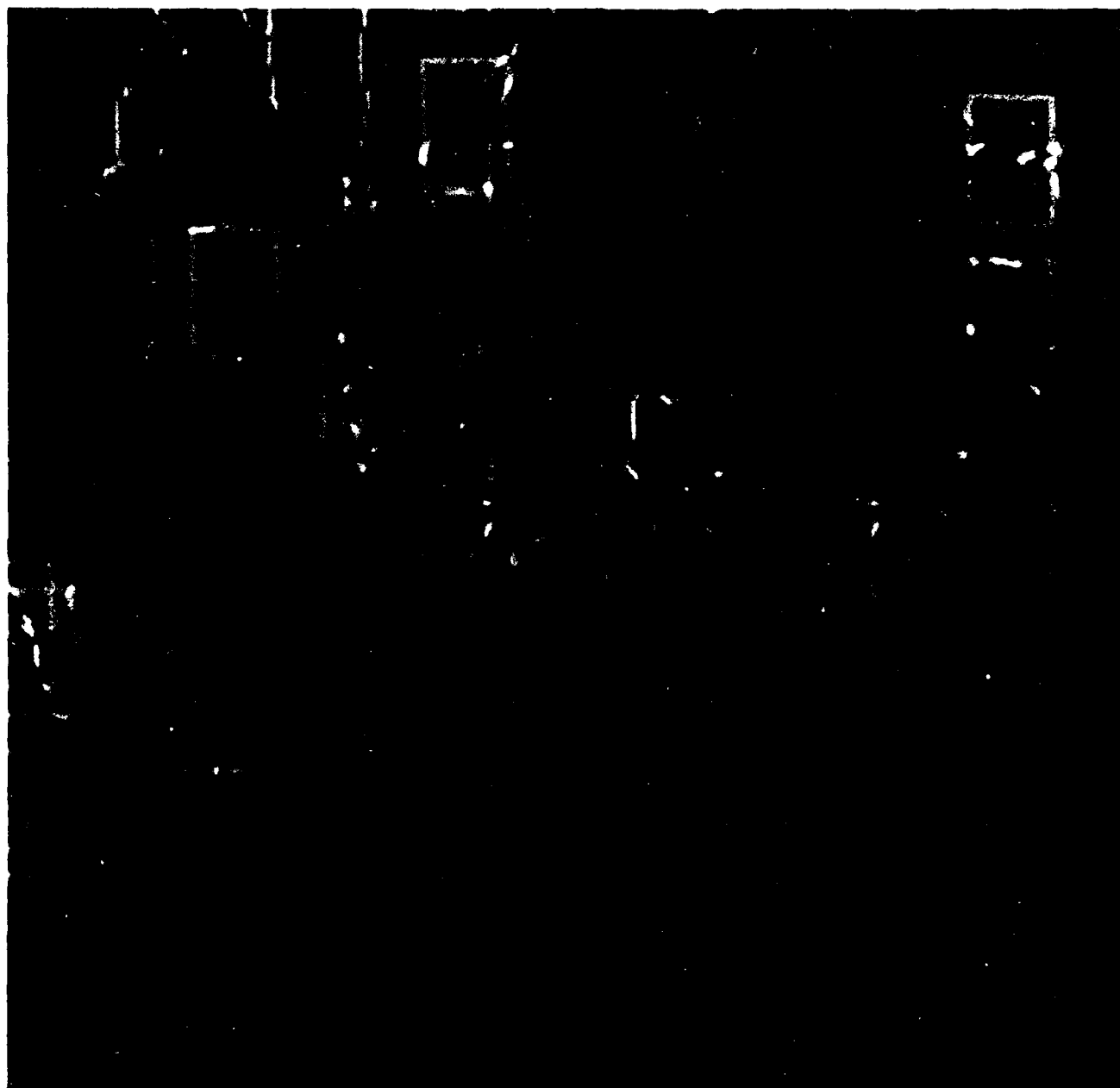
The simulated scenario now reflects combat activity. The new intelligence data collected against this scenario show the movement of units (indicated by red lines) and the operation of more air defense units. These changes are reported to the friendly commands. The TEMPRO analyst/operator will study select areas in more detail in an attempt to find specific intent and movement destination clues.



SECOND-ECHELON DIVISION MOVEMENT

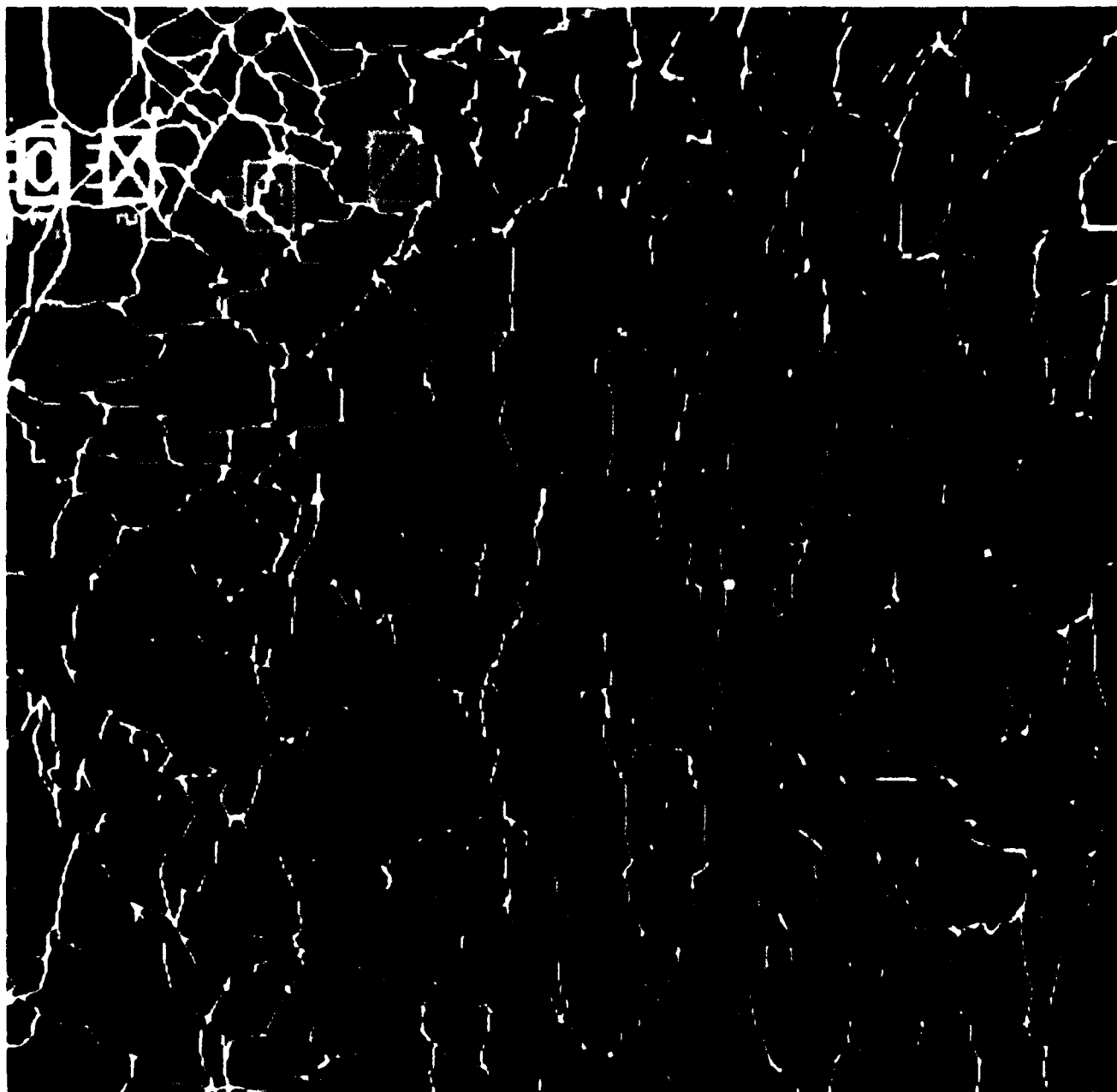
The facing figure is an exploded view of one division on the move. There are five units, two tank regiments, two rifle regiments, and an early-warning company. Following the track lines, it can be seen that the units have started to move with Unit Nos. 1 and 4 traveling in southerly direction, while Unit Nos. 2 and 3 have moved north. The early-warning company is not an attack unit and will stand relatively still.

Measurement location uncertainty of the collected intelligence has introduced apparent movement of the units. The resolution of apparent movement and actual movement is a very important function of the TEMPRO algorithms. Sometimes the algorithms cannot separate these effects, however, causing the analyst to carefully evaluate the entire set of data displayed to make a determination, if possible. This is the probable beginning of an attack movement. With early warning of such movement and meaningful projections of future enemy locations, the user will be able to assess the second-echelon threat.



FORCE MOVEMENT PROJECTION

Projecting the second-echelon units ahead in time is the function of LAMAS, the program that operates on TEMPRO output as described in Section 1. The four movement units of the division described on the previous page are input to LAMAS and displayed. Initial conditions for LAMAS appear on the facing page.



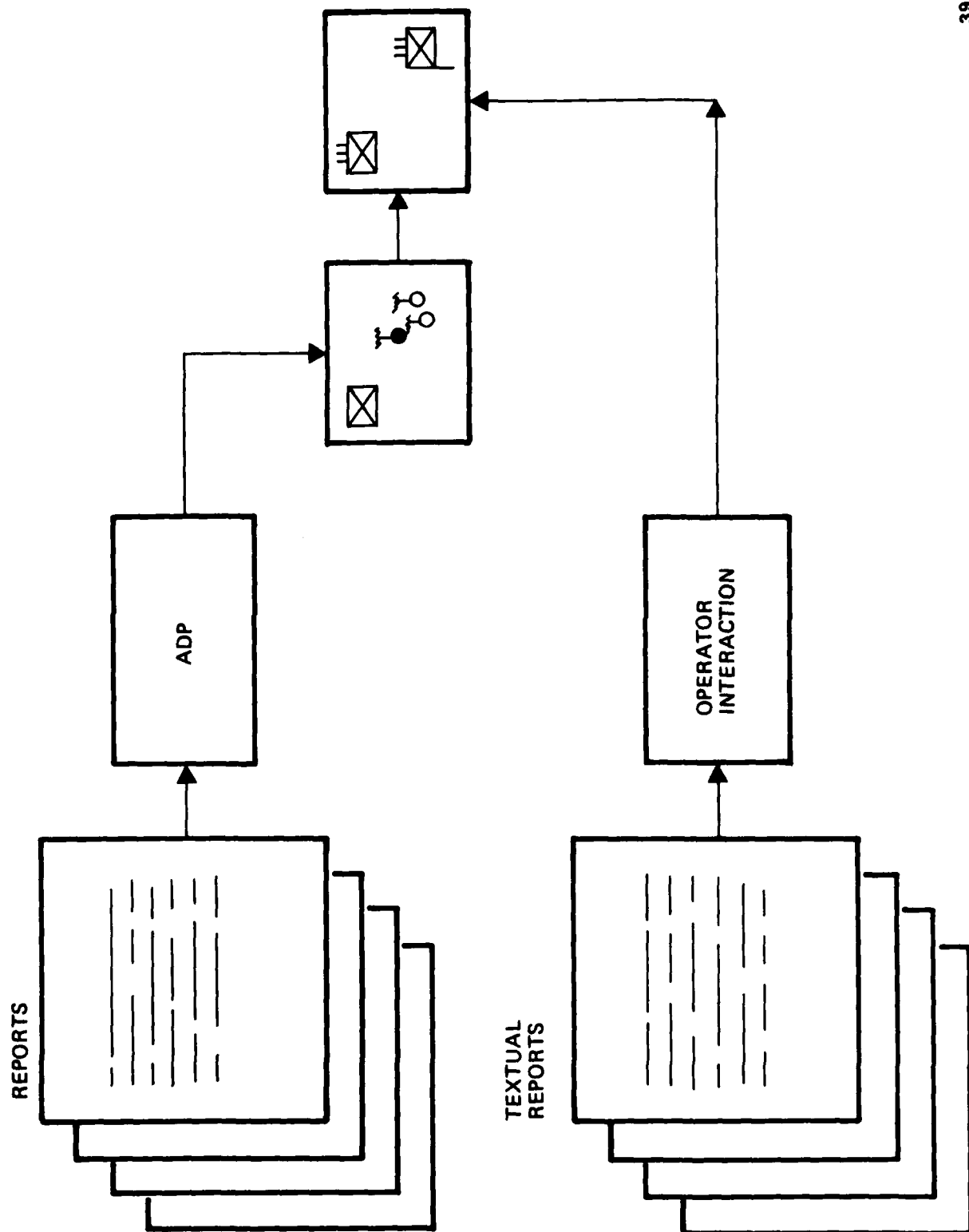
5. INTELLIGENCE MESSAGES FOR TEMPRO

INTELLIGENCE MESSAGES FOR TEMPRO

TEMPRO is a program designed to operate with fixed-field alphanumeric input data or data that can be depicted graphically. Fixed-field alphanumeric data are in a form that allows the computer program to route the data to appropriate files and feed the algorithms without manual intervention. High-volume intelligence collection systems will offer these types of data to the battlefield tactical intelligence organizations in the 1980 time frame.

Data that can be depicted graphically by an analyst can also be operated upon by TEMPRO, but require manual input. This kind of data may be inferred from textual reports such as a TACREP. The bulk of textual reports contains much valuable information that is sometimes similar to the output of TEMPRO. The handling of textual reports in conjunction with the TEMPRO output is not addressed in this study.

The facing diagram depicts two kinds of data coming together in TEMPRO. Textual information may contain the results of intercepted message traffic which, when combined with fixed-field reports, enables accurate unit location determination and identification of enemy units. This section expands on the message types that TEMPRO was designed to handle.



THE FIXED-FIELD INTELLIGENCE MESSAGES

Fixed-field messages contain intelligence that will be operated upon by data processing equipment. HOTPHOTOREP, TACELINT, communicative IPF, and IPIR messages are examples. Here, using the image on the previous page, a message has been prepared that reflects the extreme time urgency of intelligence to a tactical commander. The analyst has rapidly scanned the image and has recorded his observations using numerical values and prearranged codes. The first line indicates the time of image collection; the location (in modified UTM coordinates); a collection source code (to maintain collection security); and the target ID by name, target type (e.g., tank), level, and subtype (e.g., medium). The second line indicates the unit state (e.g., marching), length, width, movement direction (with an indicator if the polarity is ambiguous), and the uncertainty ellipse semi-major and minor axes with the orientation of the major axis (if available). The third, fourth, and fifth lines indicate vehicle and ground order of battle object count for confirmed, probable, and possible levels of analyst confidence.

The message indicates that a regimental-sized unit is located at 5640, 607 at time 1015z on the 27th day of the month in a static state spread over 600 by 300 meters pointed at azimuth 315 (or 135) degrees from north with no location error (the photograph registers to local roads). There are 105 confirmed vehicles, two probable vehicles, one probable large wheeled vehicle, and one possible vehicle. Two objects are reported as possible 60B items. The analyst cannot rapidly determine that most of the vehicles are tanks.

(HEADER INFO)

TAG 0241

PHOTIME/LAT/LONG/SOURCE/TGT ID/TGTTYP/LEVEL/SUBTYP

2710152 5640 607 3 UNK UNK REG UNK

STATE/LENGTH/WIDTH/DIR/MAJ AX/MIN AX/OR

STAT 6 3 315+ 0 0 0

CONVEH/VEH/LGWH/SMWH/TRK/TNK/TO/CONGOB

105 105

PROVEH/VEH/LGWH/SMWH/TRK/TNK/TO/PROGOB

3 2 1

POSVEH/VEH/LGWH/SMWH/TRK/TNK/TO/POSGOB

1 1 2

TACELINT MESSAGE

The TACELINT fixed-field intelligence message is particularly adaptable to computer processing because of the amount of quantitative data that can be matched. Here is a hypothetical message of a hypothetical radar intercept.

SOI/B987/LOW FELLOW/DT:060812Z/LT:0821Z/152253.5N/1015030.5E
027DGM/02.4 NM/01.8 NM/
PRM/728 MHZ/D/PRI:20015.3/D/PD:03.2/
CIRC/2.4 SEC/HORIZ

COMMUNICATIONS IPF MESSAGE

Communication Intercept and Position Fixing (IPF) includes the collection and analysis of signal characteristics and the location of the emitter. IPF results in information like that included in a TACELINT message. The example on the facing page shows a series of IPF reports collected and grouped together in one message.

HDF/272136Z1/701623/USZS/12504067HZ/RL
ELLIP/3703N3/12245W4/148T/65NM/31NM/6380SQNM
HDF/272151Z8/701628/ESBZ/12512961HZ/RL
ELLIP/3700N0/12253W3/158T/106NM/38NM/12700SQNM
HDF/272156Z3/701630/ULQA/12581741HZ/RL
ELLIP/3630N2/12310W7/011T/46NM/19NM/2880SQNM
HDF/272206Z9/701643/NSUP/08346941HZ/TU
ELLIP/3545N7/12829W2/289T/38NM/20NM/2520SQNM
HDF/272209Z2/701645/NC/12470148HZ/TU
ELLIP/2949N4/1320PW6/054T/57NM/18NM/2190SQNM
HDF/272219Z3/701658/NC/12461602HZ/TU
ELLIP/2305N0/13203W9/167T/78NM/65NM/16040SQNM
HDF/272228Z3/701665/JEMM/16735823HZ/TU
ELLIP/3600N9/13336W6/095T/72NM/26NM/6060SQNM

THE TEXTUAL INTELLIGENCE MESSAGE

Textual messages such as MISREP, INTSUM, and DISUM contain finished intelligence that describes enemy unit status, intent and action. The message prepared here is the result of careful image interpretation and correlation with enemy equipment. The analyst has been able to determine that the unit is a tank regiment with a collocated air defense battery. Because the analyst has access to numerous other images, he indicates that this regiment may be attached to a specific division. Textual messages contain a great deal of information, but normally are not as timely as fixed-field messages. Data processing is also difficult with textual messages, as noted during the 1976 BOLD EAGLE exercise.

NAR/TAB 0241. AN APPARENT LEAD TANK REGIMENT IS RESTING IN TIGHT FORMATION 3.5 KM EAST OF EISENACH (NB961478) AT 1015 27 AUGUST. SUSPECT THIS REGIMENT TO BE PART OF DIVISION FORMING IN ERFORT AREA (PB400500). AA UNITS PRESENT, PROBABLY FOUR Z5U-23/4 AND FOUR SA-9 VEHICLES. TANKS APPEAR TO BE T-62 CLASS. BATTALIONS MAY NOT BE FULL STRENGTH. NO LOGISTICS OBSERVABLE NEARBY.

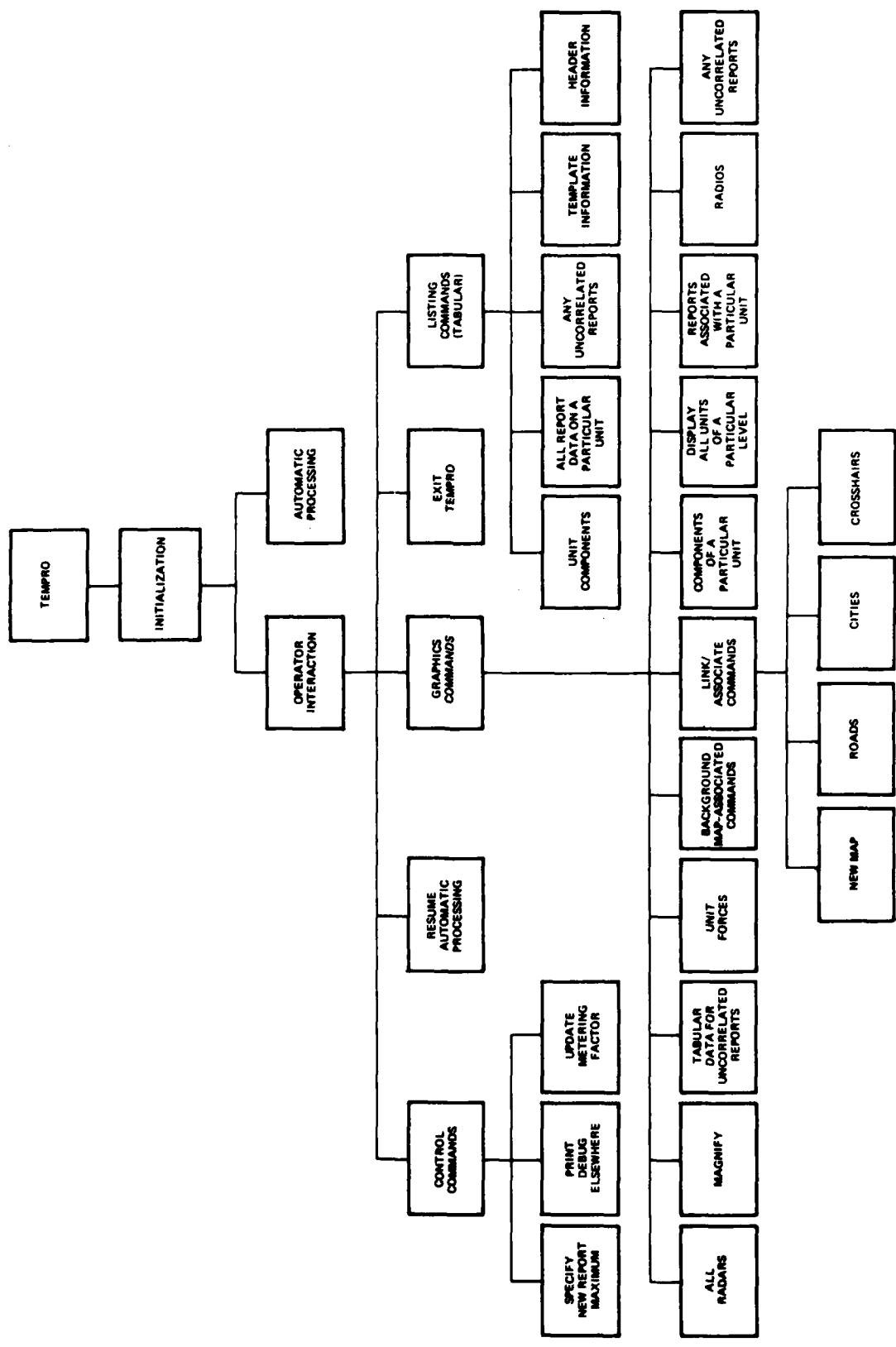
6. THE TEMPRO SOFTWARE STRUCTURE OVERVIEW

THE TEMPRO SOFTWARE STRUCTURE OVERVIEW

TEMPRO is a modular programming system as illustrated by this block diagram of the TEMPRO functions. Its primary method of communicating with the user is a menu from which the user may choose a desired function. For example, the operator interaction menu has five entries: CONTROL COMMANDS, LISTING COMMANDS, GRAPHICS COMMANDS, RESUME PROCESSING, and EXIT TEMPRO. If any of the first three is chosen, a new menu will appear. Eventually the user will choose a function that performs a certain task (such as displaying a road or printing a report). When this situation arises, the user is prompted to enter appropriate data at the terminal.

To operate the program, TEMPRO is loaded and OPERATOR INTERACTION is selected. This allows the operator to set the conditions for operation. To start processing a stream of intelligence data, AUTOMATIC PROCESSING is selected. This processing will continue to respond to message data as they are input. The operator can interrupt and enter OPERATOR INTERACTION to perform analysis functions.

The automatic correlation algorithms are contained within AUTOMATIC PROCESSING. These algorithms perform templating and report-to-report and report-to-unit correlations. Algorithm details are contained within the Programming and User Manual, CDRIL Item A0101. All software is described in Program Design Language. The entire TEMPRO program contains approximately 7000 lines of FORTRAN-equivalent code.



7. SYSTEM HARDWARE

SYSTEM HARDWARE

The system hardware configuration at the Signal Processing Facility where TEMPRO was implemented consists of four computers - a PDP-11/60, two PDP-11/45s, and a PDP-11/35 - with links between each other as shown. TEMPRO works on either the PDP-11/60 or the PDP-11/45. Each of these machines has a number of peripherals available, but TEMPRO only uses a COMTAL 8300 imaging display, the RP-04 disk, and either a Tektronix 4014 CRT or one of the Decwriter terminals. All hard-copy output is printed on the Gould printer-plotter. TEMPRO also was modified to operate on the PDP-11/70 under RSX-11D at the U.S. Army Ft. Hood facility.

TRW SIGNAL PROCESSING FACILITY

